



First records of Cheirodontinae (Actinopterygii: Characiformes: Characidae) from drainages of Espírito Santo state, southeastern Brazil

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Abstract: Recent samples revealed the first occurrences of *Serrapinnus heterodon* (Eigenmann) in three different sample sites from two drainages in northern Espírito Santo state, Brazil. This is also the first record of the subfamily Cheirodontinae for this State, whose territory is completely inserted in the Atlantic Rainforest ecoregion. The new records of *S. heterodon* were found with known introduced species and far outside of its usual distribution. This leads us to believe that its presence in the region may be the result of an introduction.

Key words: systematics; Neotropical region, Atlantic Rainforest, freshwater fish

Cheirodontinae Eigenmann, 1915 is a monophyletic subfamily of Characidae comprising 16 genera and 67 valid species that occur in most Neotropical river basins from Costa Rica to central Chile and Argentina (Malabarba 1998, 2003; Eschmeyer and Fricke 2016; Jerep et al. 2016). The group is diagnosed by the presence of a large characteristic triangular pseudotympanum, lack of humeral spot, pedunculated teeth largely expanded and compressed distally, and premaxilla with a single regular and perfectly aligned tooth row (Malabarba 1998).

Espírito Santo state is completely within the Atlantic Rainforest biome, the second most threatened environment of the World (Campalini and Pachnow 2006). Consequently, the entire region is included in the Atlantic Forest ecoregion (Northeastern Mata Atlantica *sensu* Abell et al. 2008) which comprise 16 river basins, all draining to the Atlantic Ocean (IEMA 2016). Paiva

(2004) estimated the fish fauna from Espírito Santo to include 154 species, of which 119 are exclusively in freshwater. However, recent studies suggest that this number is notably underestimated (Sarmento-Soares et al. 2012, 2014; Sarmento-Soares and Martins-Pinheiro 2012, 2013, 2014a, 2014b; Vieira et al. 2014; Mazzini et al. 2014; Plesley et al. 2014; Sartor et al. 2014).

Recent samples in northern Espírito Santo state (north to Rio Doce drainage) revealed the presence of *Serrapinnus heterodon* (Eigenmann, 1915) in a tributary of the Rio Barra Seca drainage and in two lakes, one isolated between the Rio Barra Seca and lower Rio Doce basins and the other a tributary of Rio Doce. Such specimens represent the first records of the family Cheirodontinae for Espírito Santo state and in lower course of Rio Doce drainage *sensu* Vieira (2009).

The sampling at the Córrego Ipiranga, a small sandbank tributary of the estuary of the Rio Barra Seca (Linhares, Espírito Santo state) was performed in 29 April 2015 under SISBIO permit number 48489-1 to LFSI, using beach seines, sieves and cast nets. Collected specimens were fixed at 10% formalin, transferred to preservative solution of 70% ethanol, identified and deposited at Coleção Zoológica Norte Capixaba (CZNC, Universidade Federal do Espírito Santo, São Mateus). Additional comparative material are deposited at Instituto Nacional da Mata Atlântica (MBML, former Museu de Biologia Mello Leitão, Municipality of Santa Teresa, Espírito Santo state), and Museu Nacional (MNRJ, Universidade Federal do Rio de Janeiro, Rio de Janeiro).

The sampled site is located at the middle course of Barra Seca stream (19°15'51" S, 039°43'12" W; Figure 1). Here, the river is highly disturbed and the river channel

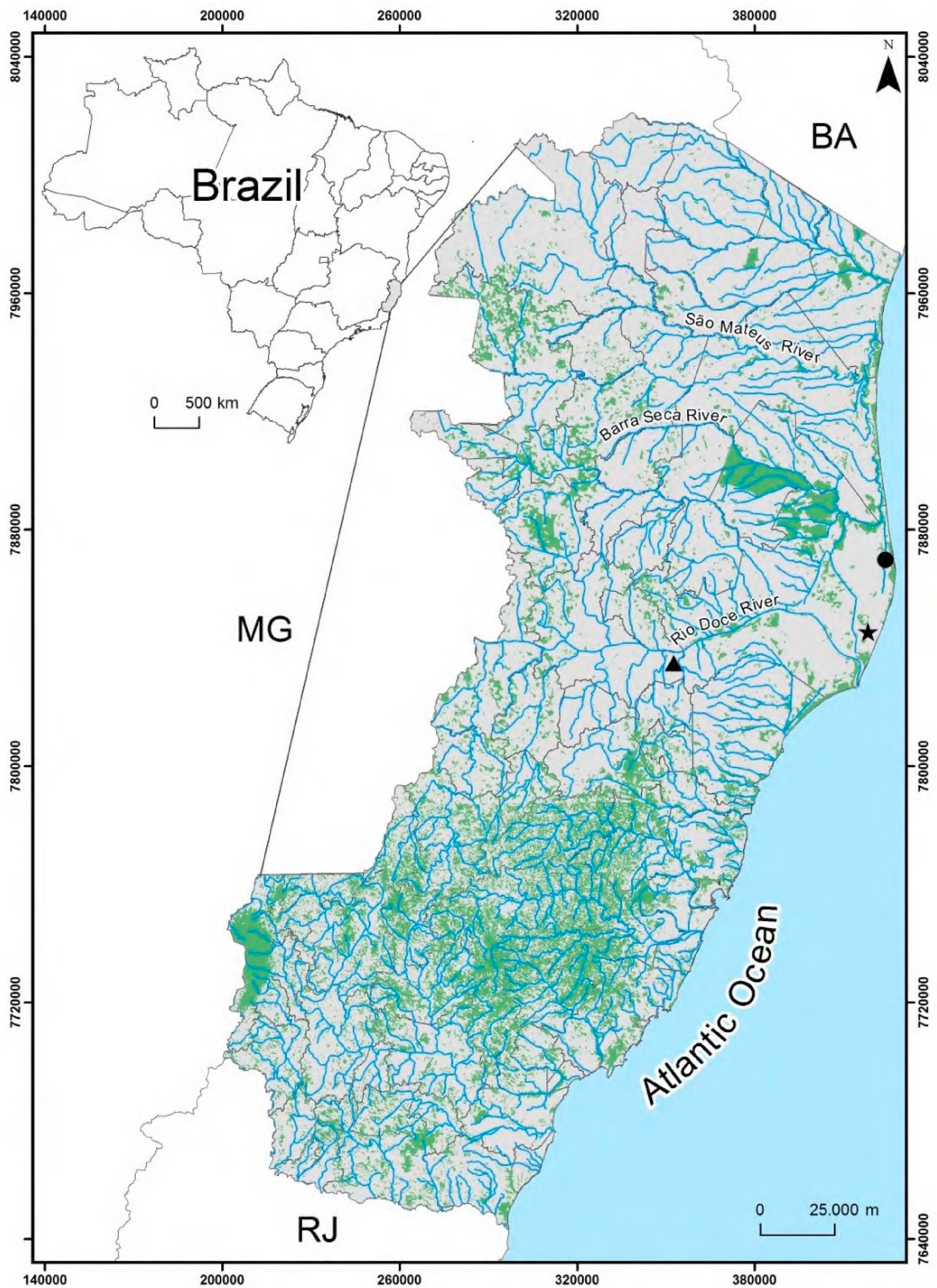


Figure 1. Distribution of *Serrapinnus heterodon* in Espírito Santo state. Circle: Córrego Ipiranga (CZNC 1127). Star: Lagoa do Doutor (MBML 9827). Triangle: Lagoa da Cobra Verde or Pau-Gigante (MBML 9800). Green: Atlantic Rainforest.



Figure 2. *Serrapinnus heterodon* (CZNC 1127, female, 31.3 mm SL).

is partially modified for an oil pipeline crossing. The original vegetation of the site was completely replaced by pasture, with some riverine and aquatic vegetation (Figure 3). The bottom substrate is composed of sand. The water is dark, 26.7°C, with zero salinity; conductivity 350 μ S, pH 6.66, oxygen 1.27 mg/l, TDS 249 ppm, and turbidity 26.4 FTU. Environmental data of the water were obtained with Oakton PCSTestr 35 multi-parameter, Hanna HI942 dissolved oxygen probe, and Hanna HI93703 turbidity meter.

From the middle course of the stream (Figure 1) one female specimen of *Serrapinnus heterodon* was collected (CZNC 1127, 31.3 mm SL, see Appendix) (Figure 2),

which represents the first record of Cheirodontinae from Espírito Santo state. A search in the fish collection of MBML revealed the presence of two additional records of *S. heterodon* for the region: Lagoa da Cobra Verde (= Lagoa Pau-Gigante), tributary of Rio Doce, and at Lagoa do Doutor, an isolated freshwater lake near the mouth of Rio Doce (Figure 1). Those MBML specimens were examined and re-identified here. Since these specimens were collected by others, and are part of the testimony material of ongoing environmental studies at Rio Doce basin in Espírito Santo state (restricted data), additional information about the sample site is not available.

The specimens were identified according to Eigenmann



Figure 3. Sample site of *Serrapinnus heterodon* at Córrego Ipiranga, Linhares, ES.

(1915), Géry (1977), Malabarba (1998), Malabarba and Weitzmann (1999) and comparative material from MBML and MNRJ by the presence of a complete lateral line (*versus* incomplete in most species of the subfamily and almost complete in *Acinocheirodon melanogramma*), and the presence of teeth with different formats and number of cuspids in upper and lower jaws (*versus* teeth with similar appearance in both maxilla, except in *A. melanogramma*). From *A. melanogramma*, a species from São Francisco and Jequitinhonha River basins, the specimens are distinguished by the presence of a completely perforated lateral line (*versus* last one to three scales of longitudinal row not perforated); caudal spot not extending over caudal-fin rays (*versus* caudal spot covering the medial caudal-fin rays, but not extending to its tip); presence of seven scale rows between dorsal-fin origin and lateral line (*versus* six scale rows above lateral line); and dorsal fin hyaline (*versus* presence of a small dark bar between first and second dorsal-fin rays in *A. melanogramma*).

Serrapinnus heterodon was collected in Córrego Ipiranga together with *Prochilodus lineatus* (Valenciennes, 1837), *Astyanax* aff. *intermedius* Eigenmann, 1908, *A. lacustris* (Lütken, 1875), *Hoplosternum littorale* (Hancock, 1828), *Poecilia vivipara* Bloch & Schneider, 1801, *Oreochromis niloticus* (Linnaeus, 1758), *Eleotris pisonis* (Gmelin, 1789), and *Synbranchus marmoratus* Bloch, 1795. Several dry craniums of *Clarias gariepinus* (Burchell, 1822) were found scattered on land and in the water.

Serrapinnus Malabarba, 1998 is the most diverse and widely distributed cheirodontine genus, comprising 15 species recorded from most of the cis-Andean river basins (Malabarba and Jerep 2014; Jerep et al. 2016). The genus is a monophyletic lineage that presents incomplete lateral line, as most of Cheirodontinae (except in *S. heterodon*). Mature males exhibit a ventrally curved caudal peduncle and hypertrophied hooks on the anal-fin rays that may result in fused ray segments (the latter also present in some other genera of the subfamily). There is also a high number of ventral procurrent caudal-fin rays (also shared with other subfamily genera), of which the most anterior rays are anteriorly directed and the remaining ones are perpendicular to the longitudinal axis of the body (Malabarba 1998).

Serrapinnus heterodon is possibly the most widespread cheirodontine species, occurring in São Francisco and upper Paraná River basins and coastal drainages from northeastern Brazil (Malabarba 2003, 2007; Malabarba and Jerep 2014). New records of this species were recently reported from Recôncavo Sul (southern Recôncavo region) coastal drainages in Bahia state (Burger et al. 2011) and the middle Rio Doce basin in Minas Gerais state (Vieira 2009). In both cases, previous authors considered the occurrence as a natural

event. However, *S. heterodon* has been recorded from Rio Doce basin only recently (Vieira 2009), and only from its middle stretch in the Rio Santo Antônio basin (Minas Gerais state). Although the headwaters of the Rio Doce are considered the best sampled region of the basin (Vieira 2006, 2009), there are no records of the species from there. This lead us to reject the possibility of a headwater capture event in the São Francisco and Doce river basins as the possible point of dispersion of *S. heterodon* in the Rio Doce. Several allochthonous species were sympatric with *S. heterodon* in the Rio Doce (Vieira 2009) and at Córrego Ipiranga (*Prochilodus lineatus*, *Oreochromis niloticus* and *Clarias gariepinus* (and with *Pimelodus maculatus* Lacepède, 1803 and *Pygocentrus nattereri* Kner, 1858 collected upstream). Due to the occurrence of these non-indigenous species living with *S. heterodon* and the disjunct occurrence of this species in separate distant drainages, we consider its presence in Rio Doce and Rio Barra Seca basins as the result of a possible accidental introduction along with other species of commercial interest.

In addition to the allochthonous species recorded at the sites sampled in this study, apparently countless other species, including aquarium fishes and farmed fishes, are being recorded in northern Espírito Santo state. It is thought that these introductions may have at least two sources, from fish farms with low standards of environmental safety, which could allow the escape of individuals, or historically by some kind of influence or incentive from actions of Departamento Nacional de Obras Contra a Seca (DNOCS, National Department of Works Against Drought) in neighboring regions (DNOCS 2009). The dispersal of these allochthonous fish is probably aided during flood events when local drainages overflow and potentially connect with other drainages. An overflow and connection of the lower Doce, Barra Seca and São Mateus River basins was observed by the authors in December 2013.

The recent records of *S. heterodon* and other freshwater species (e.g., *Kryptolebias ocellatus* (Hensel, 1868); Sarmiento-Soares et al. 2014) in northern Espírito Santo state reveal how insufficiently the freshwater ichthyofauna is known in the state. This also denotes the importance of the recent surveys by the authors in the region since 2009, which are indispensable to understand the relationships among the drainages of Espírito Santo state, as well as their management and resources restoration.

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Author contributions: LFSI collected the data, identified the specimens and wrote the manuscript. LFD collected the data, helped with identification and contributed with the text. TG organized and collected the data, and contributed with the text. LMSS examined the MBML collection, identified the specimens of this collection, and contributed with the text.

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APPENDIX

Material examined

Serrapinnus heterodon. Brazil. Espírito Santo. CZNC 1127, 1 (31.3 mm SL); Linhares, Córrego Ipiranga, tributary of rio Barra Seca, 19°15'51" S, 039°43'12" W; Leg. L.F.S. Ingenito, L.F. Duboc,

N. Sartor, T. Gomes, G. Lírio and D.M. Souza; 29 Apr 2015. MBML 9800, 3 (28.0–32.6 mm SL); Colatina, Lagoa da Cobra Verde or Pau-Gigante, tributary of rio Doce, 19°52'57" S, 040°24'27" W; Leg. G.I. Almeida and A. Anastácio; 19 Feb 2014. MBML 9827, 5 (21.3–25.1 mm SL); Linhares, Lagoa do Doutor, 19°28'59" S, 039°46'39" W; Leg. G.I. Almeida and A. Anastácio; 19 Feb 2014.

Serrapinnus piaba. Brazil. Bahia. MBML 8721, 2 (34.0–35.0 mm SL); Santa Maria da Vitória, Rio Correntina on unpaved road between BR-349 and Barra de São José village. Leg. A.L.Carmassi; 30 Jan 2014. MBML 8738, 3 (26.7–27.0 mm SL); Santa Maria da Vitória, Rio Correntina on unpaved road between BR-349 and Barra de São José village. Leg. A.L.Carmassi; 30 Jan 2014. MBML 8854, 7 (14.7–17.7 mm SL); Guanambi, swamp area on rio Carnaíba de Dentro margin, near BA-573; Leg. A.L.Carmassi; 30 Jan 2014. MBML 10900, 5 (18.2–26.5 mm SL); São Desidério, Rio Grande, unpaved road between BA-462 and Das Almas village. Leg. G.I.Almeida, A.Anastácio and L. N. Rodrigues; 25 Aug 2015.

Acinocheirodon melanogramma. Brazil. Minas Gerais. MNRJ 16455, 1 holotype (31.9 mm SL); Bocaiúva, córrego Cachoeira, tributary to Rio Jequitai, kilometer 413 of highway BR 135, 17°28' S, 044°22' W. Leg. D. F. Moraes Jr; 24–30 Sep 1990.